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ELECTROTECHNICAL VOCABULARY

PART IV ELECTRON TUBES

Section 6 Noise in Microwave Tubes

(Second Reprint JUNE 1996)

UDC 001.4 : 621.385.6 : 534.839

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ELECTROTECHNICAL VOCABULARY

PART IV ELECTRON TUBES

Section 6 Noise in Microwave Tubes

0. FOREWORD

0.1 This Indian Standard (Part IV/Sec 6) was adopted by the Indian Standards Institution on 17 April 1972, after the draft finalized by the Electrotechnical Standards Sectional Committee in consultation with the Electron Tubes Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 While preparing this standard, assistance has been derived from the IEC document 39A (Secretariat) 35 'Terms applicable to the measurement of noise (Draft supplement to Publication 235-1)'.

0.3 This standard is one of a series of standards on electron tubes. A list of standards so far published in this series is given on Page 12.

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1. SCOPE

1.1 This standard (Part IV/Sec 6) deals with terms and their definitions relating to noise in microwave tubes.

2. TYPES OF NOISE

2.1 Noise

a) An effect generated by a tube and detected as undesired sound, visual disturbance, or unwanted electrical signal.

b) Random fluctuations of an electrode voltage or current originating within a tube.

2.2 R. F. Noise — Noise generated by a tube in the radio frequency band.

NOTE — Unless specified, the term 'noise' refers to R. F. noise.

2.3 Low-Frequency Noise — Noise in the low-frequency band.

NOTE — Hiss, flicker noise, shot noise are examples of low-frequency noise.

2.4 White Noise — Noise which has a uniform distribution of noise power per unit bandwidth over the whole frequency band and having no correlation between its components.

2.5 Random Noise — Noise due to the aggregate of a large number of elementary disturbances with random occurrence in time.

2.5.1 *Triangular Random Noise* — Random noise whose spectral distribution is such that the noise power per unit bandwidth is proportional to the square of the frequency.

2.6 Background Noise — Noise generated primarily within an electron tube and having a smooth (if any) variation of power density with frequency.

2.7 Thermal Noise — Noise having the same character as that produced by a resistor at some temperature above absolute zero.

Note — Thermal noise is equivalent to white noise for temperatures and frequencies in the range given by the following expression:

$$hf \ll kT$$

where

h = Planck's constant,

f = frequency,

k = Boltzmann's constant, and

T = absolute temperature.

2.8 Ion Noise — Noise caused by the presence of ions within the electron tube.

2.9 Flicker Noise — Noise caused by the random variations in the activity of the emitting surface of the cathode in a tube.

2.10 Shot Noise — The fluctuations in the current due to charge carriers passing through a surface at statistically independent times.

2.11 Hiss — Noise in the audio-frequency range, having subjective characteristics analogous to those of a prolonged sibilant sound.

2.12 Modulation Noise — Noise generated by a tube relative to a carrier and having correlated upper and lower sideband components.

2.12.1 *Amplitude Modulation Noise* (*am Noise*) — Modulation noise which has the characteristics of amplitude modulation.

2.12.2 *Frequency Modulation Noise* (*fm Noise*) — Modulation noise which has the characteristics of frequency modulation.

Note — There is no distinction between frequency and phase modulation noise from the point of view of noise measurements and hence references may be to either phase or frequency modulation noise as required.

2.13 Hum — Modulation noise arising from ac components of the power supplies to the tube.

NOTE — This term does not include the modulation noise caused by an external electrical or magnetic field, that is, a field not originating in the tube and its related supplies.

2.14 Sideband Noise — Noise appearing at a stated frequency separation from the carrier, but not necessarily correlated with the corresponding image sideband frequency.

2.15 Interpulse Noise — All rf output occurring during 'off' period conditions of an electron tube, measured in a stated bandwidth.

2.16 Intrapulse Noise — Excess noise occurring during 'on' period conditions of an electron tube.

2.16.1 *Intrapulse Noise (Non-active Conditions)* — Excess noise occurring during 'on' period non-active conditions of an electron tube.

2.16.2 *Intrapulse Noise (Active Conditions)* — Excess noise occurring during 'on' period active conditions of an electron tube.

2.17 Crackling — Abrupt changes of an electrode current caused by variations in insulation or contacts.

2.18 Microphone — Variations of electron tube parameters resulting from instantaneous movements or mechanical deformations of tube elements.

2.19 Audible Noise — Undesired sound emanating directly from a tube and caused by mechanical, acoustical, electrical or magnetic excitation.

2.20 Partition Noise — Noise caused by random fluctuations in the distribution of current between the various electrodes.

2.21 $\frac{1}{f}$ Noise — Noise, amplitude of which varies as $\frac{1.}{f}$

2.22 Contact Noise — Noise due to variations in electrical resistance at the junction of two metals or of a metal and a semiconductor.

2.23 Impulse Noise — Noise characterized by transient disturbances separated in time interval by quiescent intervals.

NOTE — The frequency spectrum of these disturbances should be substantially uniform over the useful pass-band of the system.

3. NOISE POWER

3.1 Noise Power, P_n — Radio-frequency power having the character of noise within a stated frequency band, and averaged over a stated time interval.

3.2 Available Noise Power, P_{an} — Noise power delivered to a matched load.

Note — The available noise power delivered by a resistor is given by $P_{an} = kTB$, where k is Boltzmann's constant, T is the absolute temperature and B is the bandwidth. In this case, the noise power shall be averaged over a time interval sufficiently greater than the periodic time of the lowest frequency in the band of measurement.

3.3 Reference Noise Power, P_{on} — The available noise power delivered by a resistor at a stated reference temperature, usually 290°K.

3.4 Excess Noise Power, P_{en} — The difference between the noise power delivered by the tube being measured, or the noise source, and the reference noise power which would be delivered by a hypothetical resistor of equivalent value.

Note — Unless otherwise specified, the term *excess noise* refers to *excess noise* power.

4. NOISE TEMPERATURE

4.1 Noise Temperature, T_n — The temperature at which a hypothetical resistor shall be set so that it delivers the same noise power as the source to which it is equivalent.

4.2 Reference Noise Temperature, T_{on} — The temperature of a source delivering reference noise power.

Note — When a resistor is used as a source, the reference noise temperature is usually 290°K.

4.3 Excess Noise Temperature, T_{en} — The difference between the noise temperature of the tube being measured, or a noise source, and a reference noise temperature.

4.4 Equivalent (or Effective) Noise Temperature, T_e — The noise temperature of a tube, when it is different from the physical temperature of the source noise, such as in a gas discharge noise tube or electron beam noise generator.

4.5 Effective Input Noise Temperature

a) The excess noise temperature of an amplifier referred to its input.

b) The excess noise temperature necessary at the input of an equivalent noiseless amplifier to produce the same noise power at the output of the actual amplifier, with an input termination at reference temperature.

4.6 Operating Noise Temperature

a) The noise temperature of an amplifier referred to its input.

b) The noise temperature necessary at the input of an equivalent noiseless amplifier to produce the same noise power at the output of the actual amplifier with an input termination at reference temperature.

4.7 Noise Temperature Ratio — The ratio between the noise temperature and the reference noise temperature.

4.8 Excess Noise Ratio, ENR — The ratio between the excess noise temperature and the reference noise temperature.

NOTE — This may also be given as the ratio between the excess noise power and the reference noise power.

5. NOISE RATIO AND FACTOR

5.1 Signal-to-Noise Ratio — The ratio between the square of the modulation index of the signal and the mean square of the modulation index of the noise over a stated time interval and a stated band of frequencies.

5.2 Carrier-to-Noise Ratio — The ratio between the integral of the carrier power density and the integral of the noise power density, each integral being taken over a stated band of frequencies and a stated time interval.

NOTE 1 — The stated band of frequencies for integration of noise power is simply that required for a particular measurement, but the band for carrier power is not easily defined since the noisy carrier cannot be considered to exist at a single frequency and hence the carrier and noise bands may overlap.

NOTE 2 — For high values, this may also be expressed as the ratio between carrier plus noise power to noise power as the difference is rarely significant.

5.3 Noise Factor (of an Amplifier Tube)

a) The ratio between the available noise power delivered by the tube within a stated frequency band, and the available noise power which would be delivered in the same frequency band if the tube was noiseless.

b) The ratio between the carrier-to-noise ratio at the input, and the carrier-to-noise ratio at the output.

5.4 Average Noise Factor — The noise factor averaged over a stated frequency band which represents the working frequency band of the tube being measured.

5.5 Spot Noise Factor — The noise factor in which the bandwidth of measurement is small enough to measure the peak value of a narrow band irregularity of noise factor.

5.6 Noise Factor Degradation — The change in noise factor caused by tube substitution or by tube ageing or by a change of operating conditions of the tube being measured.

6. MISCELLANEOUS

6.1 S-Effect — Modulation of an electrode current caused by the variation of the electrical change on the glass envelope or on other insulating parts of the the tube.

6.2 Noise Window — A sharply defined narrow frequency band within which the sensitivity of power measurement is uniform and total noise power may be measured.

6.2.1 *Psophometric Noise Window* — A noise window in which the sensitivity of power measurement varies across the narrow frequency band, the variation corresponding to the frequency characteristic of a telephone receiver.

6.3 Equivalent Noise Resistance — That resistance which, if introduced into the input part of a perfectly noiseless tube, would produce over the appropriate frequency band, noise at the same power level as that produced in the actual tube.

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